“FLOOD MITIGATION USING SUSTAINABLE DETENTION BASIN USING FILTRATION AND CONTROLLED RELEASE FOR MARILAO RIVER LOCATED AT LOMA DE GATO, MARILAO BULACAN”

A Research Proposal

Presented to the Faculty of Civil Engineering Division

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In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science in Civil Engineering

Major in Construction Engineering

and Management

De Vera, Alyssa Joy C.

Festin, Andrei

Pascual, Euthron Matrix B.

Rodriguez, Sheila Marie A.

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RECOMMENDATION

This is to certify that this research entitled "FLOOD MITIGATION USING SUSTAINABLE DETENTION BASIN WITH FILTRATION AND CONTROLLED RELEASE FROM MARILAO RIVER LOCATED AT LOMA DE GATO, MARILAO BULACAN," prepared and submitted by Alyssa Joy C. De Vera, Andrei Festin, Euthron Matrix B. Pascual, Sheila Marie A. Rodriguez have been examined and PASSED the Pre-Oral Defense.

ENGR. ELOISA P. CADAG, Reg. CE., MACT
Research Adviser

PANEL OF EXAMINERS

Examined and approved by the Panel of Examiners in a Pre-Oral Defense with a grade of ___ on November 30, 2025, at La Concepcion College.

Engr. DANILO A. CASAS, LPT, MAEd
Chairman

Engr. CAROLINE A. ASUNCION
Member

Engr. CAMILO A. BATULAN JR., MSCM
Member

Accepted as partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering.

ENGR. JORE GIL D. GALEZA
Division Head of Civil Engineering

DR. LEILANI I. CUSACK, DBA
Dean of Instruction

CERTIFICATE OF ORIGINALITY

This certificate demonstrates the fact that the work was original to the researchers and that no other individual or group has written or published it before. Additionally, it declares that until proper acknowledgement has been given to them, no honors or recognition from other universities, colleges or higher education institutions were claimed here.

On top of that, we claim that our study's intellectual content is the product of our hard work, which required using both simple terminology and efficient presentation methods in addition to the group's original ideas.

De Vera, Alyssa Joy C.

Festin, Andrei

Pascual, Euthron Matrix B.

Rodriguez, Sheila Marie A.

Attested by:

ENGR. ELOISA P. CADAG, REG. CE., MACT
Research Adviser

Date: _____

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CHAPTER 1

The Problems and its Background

This chapter presents the overview of the study including the introduction, background of the study, theoretical framework, statement of the problem, hypotheses, scope and limitations of the study, significance of the study, and definition of terms.

Introduction

In relation to the municipal area of Marilao, Bulacan, flooding has always been an environmental as well as an economic-social problem, particularly in the case of Loma de Gato. Moreover, the Marilao River which is part of Marilao-Mevcauavan Obando River System, in certain cases, overflows during the wet seasons resulting in widespread floods, damages, threatening of livelihoods, and posing health risks. Rapid urban expansion in addition to climate change supersedes all other contributing factors toward the flooding problem (Rivera, E. C., et al 2024).

Moreover, the other contributing factors include the sediment buildup, climate change, and lack of waste management. In the context of these floods, the stern urban expansion in addition to lack of waste management and climate change extremities overwhelms the problem. One other alternative is the design and construction of an eco-friendly detention basin. A detention basin is a man-made structure designed to temporarily store stormwater runoff during heavy rains. It helps control flooding by

slowing down the flow of water before it is gradually released into rivers, drains, or the ground. Unlike retention basins, detention basins usually drain dry between storms. They also help reduce erosion, prevent overflow, and can be integrated with filtration systems to improve water quality. Detention basins usually have an outlet structure that allows water to slowly drain out after a storm, returning the basin to a dry state. They can also include filtration features such as vegetation, gravel, or sand layers that remove pollutants and sediments, improving water quality before it reenters natural waterway

Background of the Study

This study proposes a Sustainable Detention Basin in Loma, De Gato, Marilao with the goal of minimizing floods hazards and improving water quality for the Marilao River. By combining low impact development ideas with real-time management technologies, the project aims to create a flexible solution that enhances flood resilience, protect public health, and promotes environmental sustainability in the community. Additionally, controlled release systems enable regulated outflow, guaranteeing that downstream water levels stay controllable during and flooding storm occurrences.

This research will investigate the feasibility design considerations, ecological effects, and enduring advantages of establishing such a system within the local setting

of Marilao, Bulacan. It aims to enhance the expanding knowledge base on integrated and sustainable urban water management strategies in flood-affected regions of the Philippines. Enhancing drainage efficiency through hydraulic simulations of detention basins in Metro Manila and Bulacan (Aquino, et al 2020).

Theoretical Framework

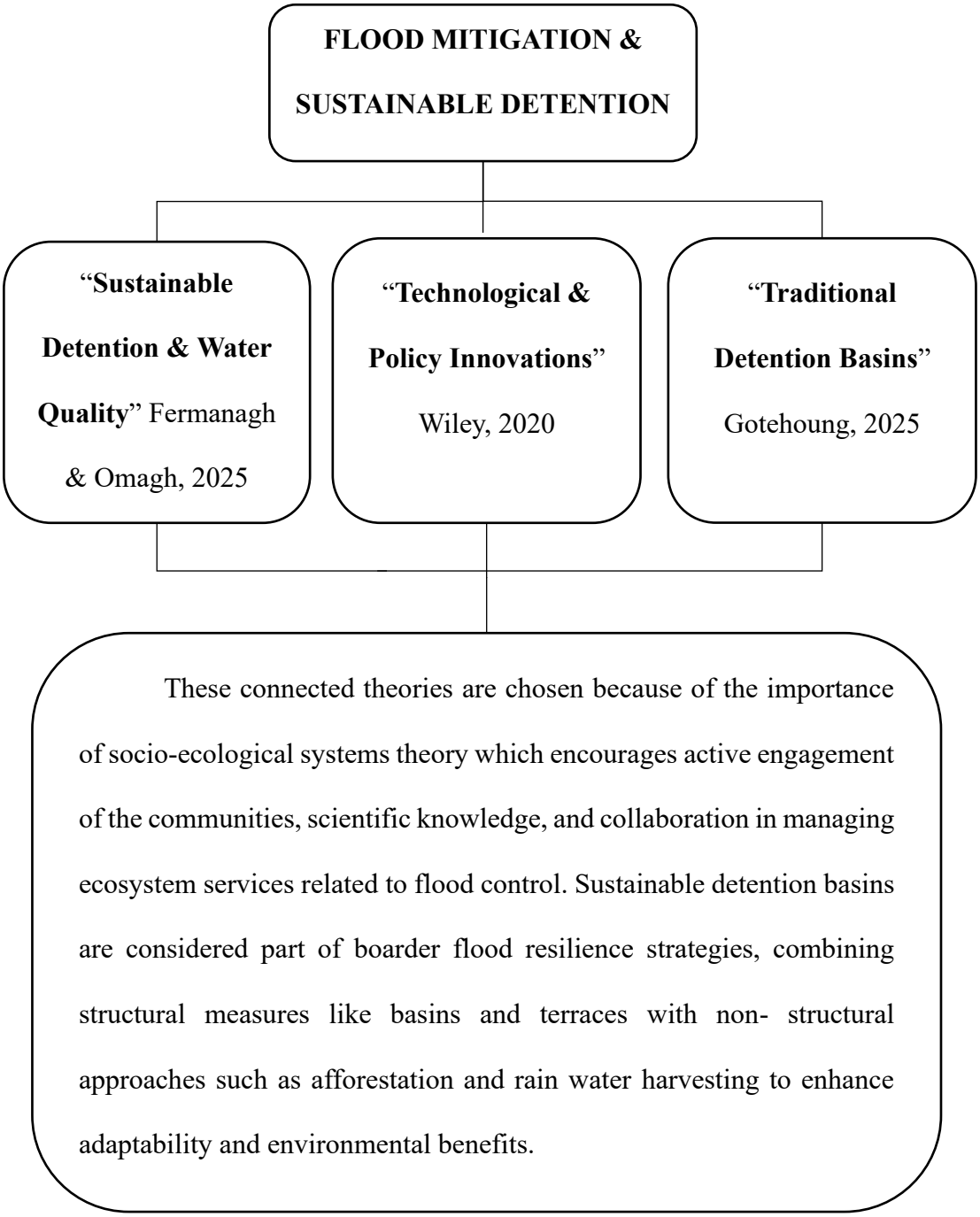
FLOOD MITIGATION &
SUSTAINABLE DETENTION
"Sustainable Detention & Water Quality" Fermanagh & Omagh, 2025
"Technological & Policy Innovations" Wiley, 2020
"Traditional Detention Basins" Gotehoung, 2025
These connected theories are chosen because of the importance of socio-ecological systems theory which encourages active engagement of the communities, scientific knowledge, and collaboration in managing ecosystem services related to flood control. Sustainable detention basins are considered part of boarder flood resilience strategies, combining structural measures like basins and terraces with non- structural approaches such as afforestation and rain water harvesting to enhance adaptability and environmental benefits.

Figure 2. *Theoretical Framework*

Conceptual Framework

INPUT	PROCESS	OUTPUT
1. What is the demographic profile for the respondents in terms of: 1.1. Age 1.2. Gender 1.3. Type of Residence 2. How can sustainable detention basin with filtration and controlled release be designed to effectively mitigate along Marilao River in terms of: 2.1. Runoff volume reduction 2.2. Water retention capacity	• Survey questionnaire • Face-to-face and Online Interview • Design the detention basin to maximize natural infiltration and evapotranspiration, allowing it to absorb and store stormwater temporarily • Control the release of water from the basin to manage runoff effectively and	• Determined how much stormwater runoff can be reduced and how much water the detention basin can hold, helping to manage flooding along the Marilao River. • Evaluated how the detention basin can work with existing drainage systems to improve flood resilience and

3. How sustainable basin be effectively integrated with existing drainage infrastructure in Loma De Gato to enhance overall flood resilience in terns; 3.1. Flood resilience 3.2. Drainage efficiency 4. How can the detention basin reduce peak levels and flooding along the Marilao River during the heavy rainfall events in terms of; 4.1. Hydrologic 4.2. Hydraulic analysis 5. How can the proposed flood mitigation project benefit the local community in terms of reduced damages and improved resilience?	prevent sudden peak flows downstream. • Integrate the basin with existing drainage systems to improve overall flood resilience, reduce pressure on current infrastructure, and remove pollutants naturally. • Analyze the system hydrologically and hydraulically to understand the timing and volume of inflows and outflows, ensuring the basin handles	make water flow more efficient. • Analyzed peak water levels and how the basin can reduce flooding during heavy rainfall using hydrologic and hydraulic studies. • Identified the benefits of the flood mitigation project for the local community, such as reducing property damage and improving overall safety and resilience.

	stormwater efficiently. • Plan and design the outlet structure based on analysis results to safely release water at controlled rates. • Evaluate community benefits by estimating how the basin reduces flood damage and improves social, economic, and physical resilience.	

Figure 3. *Conceptual Framework*

Statement of the Problem

The researcher aims to address the persistent flooding issues in Loma De Gato, Marilao River, by designing a sustainable detention basin with filtration and controlled release mechanisms for Marilao River. The study seeks to answer the following main questions;

1. What is the demographic profile for the respondents in terms of:

    1.1. Age

    1.2. Gender

    1.3. Type of Residence

2. How can sustainable detention basin with filtration and controlled release be designed to effectively mitigate along Marilao River in terms of:

    2.1. Runoff volume reduction

    2.2. Water retention capacity

3. How sustainable basin be effectively integrated with existing drainage infrastructure in Loma De Gato to enhance overall flood resilience in terns;

    3.1. Flood resilience

    3.2. Drainage efficiency

4. How can the detention basin reduce peak levels and flooding along the Marilao River during the heavy rainfall events in terms of;

4.1. Hydrologic

4.2. Hydraulic analysis

5. How can the proposed flood mitigation project benefit the local community in terms of reduced damages and improved resilience?

Objectives of the Study

The research aims to design and identify a sustainable detention basin with filtration and controlled release as a flood mitigation measure for the Marilao River in Loma De Gato, Marilao Bulacan.

1. To determine the demographic profile of the respondents in terms of:

1.1. Age

1.2. Gender

1.3. Type of Residence

2. To evaluate the design of a sustainable detention basin with filtration and controlled release to mitigate flooding along Marilao River in Loma De Gato in terms of;

2.1. Runoff volume reduction

2.2. Water retention capacity

3. To examine an effective sustainable detention basin integrated with existing drainage infrastructure along Marilao River during heavy rainfall events in terms of;

3.1. Flood resilience

3.2. Drainage efficiency

4. To investigate the efficacy of water reduction of peak water level and flooding using detention basin in terms of;

4.1. Hydrologic

4.2. Hydraulic analysis

5. To determine the benefits of the proposed flood mitigation project in the local community in terms of reduced damages and improved resilience.

Hypothesis

Ha. The implementation of a sustainable detention basin with filtration and controlled release will have a significant and positive effect on flood frequency, flood severity, water quality, and groundwater recharge in the Marilao River at Loma De Gato, Marilao, Bulacan.

Ho. The implementation of a sustainable detention basin with filtration and controlled release will not have a significant effect on flood frequency, flood severity, water quality, or groundwater recharge in the Marilao River at Loma De Gato, Marilao, Bulacan. In other words, any observed changes are due to random chance.

Significant of the Study

This study is to develop and appraise a sustainable detention basin system with filtration & controlled release for the Marilao River at Loma De Gato, Bulacan.

Hence, this study seeks to might affect several fields and populations benefit the following:

Community: This study highlight that the Detention Basin can eliminate flood risk and thus save lives and assets, while its Filtration has also helped in cutting down pollutants exposure and, as a result, bettering health in Loma De Gato, Bulacan. Besides, the reduction of flooding brings along the issues of life quality improvement, such as minor disturbance, rapid economic recovery, and safer areas, where Controlled Release is also helping by making water accessible for both community and agriculture.

Local Government: The findings of this research are aimed at being a practical reference for Loma De Gato, Marilao. One of the major solutions proposed is the Sustainable Detention Basin conceived as a green environmentally-friendly, long-term strategy that by means of green infrastructure, thereby affirming LGUs' commitment to sustainable resource management.

Environmental Agencies: This research examines the ecological restoration of the Marilao River, taking extreme pollution cases (heavy metals and waste) as the starting point. It highlights the necessity of this restoration in order to meet national environmental laws. Furthermore, the research introduces a flood mitigation and water quality enhancement model for integrated management that can be practiced in other polluted and flood-prone rivers of the country as well.

Engineers and Planners: This research gives technical information and design specifications for a water management system with multiple functions, showcasing the introduction of filtration technique and Controlled Release system in a flood detention basin situated in a tropical, dirty environment. It acts as a guide for adopting concepts of Sustainable Urban Drainage Systems (SuDS) and green infrastructure in next engineering projects.

Barangay Officials in Loma de Gato: This study provides Barangay Officials with a technical blueprint to secure funding and implement projects addressing flooding and river pollution. Moreover, through the Sustainable Detention Basin, the officials are given a way to educate the community which will not only raise awareness but also increase the safety and resilience against climate-related disasters.

Future Researchers: This study establishes a scientific baseline for the performance of detention basins with filtration, paving the way for further research on optimizing filtration media, heavy metal sequestration, and the long-term ecological impact of Controlled Release flow.

Scope and Limitation

This research focuses on evaluating the effectiveness of a sustainable detention basin with filtration and controlled release as a flood mitigation strategy for the Marilao River, particularly in Loma De Gato, Marilao, Bulacan. The research will

Assess the basin's capacity to reduce peak discharge, delay time-to-peak, and lessen inundation depth and extent during storm events.

This research is to study on Flood Mitigation using a Sustainable Detention Basin with Filtration and Controlled Release for the Marilao River located at Loma de Gato, Marilao, Bulacan is subject to several limitations. The availability and precision of secondary data, including rainfall records, river discharge measurements, soil characteristics, and topography information, are crucial to the study. Any discrepancies or gaps in these datasets could compromise the accuracy of the hydraulic and hydro logic calculations.

Definition of Terms

Climate Change – in temperature and weather patterns, often the frequency and intensity of extreme rainfall events, which worsen flood in Marilao.

Community Resilience – The ability of the residents of Loma De Gato to adapt, respond, and recover from flood hazards through sustainable infrastructure and planning.

Controlled Release – The regulated discharge of stored stormwater from the detention basin at a manageable rate to prevent overwhelming downstream drainage systems.

Detention Basin – An engineered structure designed to temporarily store stormwater runoff and release it gradually to prevent downstream flooding. In this study, it refers to the proposed basin in Loma De Gato, Marilao, Bulacan.

Filtration System – A process integrated within the detention basin to remove sediments, pollutants, and other impurities from stormwater before it is released back into the river system.

Flood Mitigation – Strategies or measures aimed at reducing the severity and frequency of flooding and its impacts on communities, infrastructure, and the environment.

Flood Resilience – The capacity of a community or area to prepare for, withstand, and recover quickly from flooding events, often through infrastructure and sustainable water management systems.

Hydraulic Analysis – The study of water flow in open channels and structures, used to determine the effectiveness of the detention basin design in mitigating flood impacts.

Hydrology – The scientific study of water movement, distribution, and management on Earth, particularly relevant here for understanding river flow, rainfall, and flooding dynamics.

Low Impact Development (LID) – A sustainable land planning and engineering design approach aimed at managing stormwater runoff through natural processes such as infiltration, filtration, and storage.

Peak Flow/Peak Discharge – The maximum rate of water flow during a storm event. Reducing peak flow is one of the main objectives of the proposed detention basin.

Sediment Buildup – The accumulation of soil, silt, and debris in river systems, which reduces water-carrying capacity and increases the risk of flooding.

Runoff – The portion of rainfall or stormwater that flows over land surfaces and into rivers or drainage systems, often contributing to flooding if unmanaged.

Stormwater Management – The planning, design, and implementation of systems to control and use stormwater efficiently to minimize flooding and water pollution.

Sustainable Detention Basin – A detention basin designed with eco-friendly materials, natural filtration systems, and controlled release mechanisms, aiming not only to mitigate flooding but also to improve water quality and support environmental sustainability.

Water Quality Improvement – The process of reducing pollutants, sediments, and contaminants in water, which is a secondary benefit of the detention basin filtration system.

CHAPTER 2

Review related Literature and Study

This chapter presents a review of related literature and studies, following a thorough search done by local and foreign researchers. Those also included in this chapter to familiarizing with relevant and similar information to the current study.

Foreign Literature

According to Kim, S. et al (2022) this study explores the integration of green detention basins with urban drainage systems for enhanced flood resilience in coastal cities. It emphasizes the role of green detention basins in managing stormwater, reducing peak discharge, delaying runoff, and enhancing flood resilience under the pressures of climate change and urbanization.

According to Thompson, A. M., & Smith, R. B. (2021), enhancing urban flood resilience through sustainable detention basin integration: A case study in the Thames River Basin. To improve flood resilience, and investigates the incorporation of sustainable detention basins into urban flood management systems. And how detention basins help manage rainwater and lessen flood peaks, highlighting the value of low impact, nature-based flood risk management strategies, as well as the efficiency and operational optimization of detention basins for reducing urban floods.

According to Li, X. at el. (2023) research study examined the use of hydrologic models to analyze and optimize the effectiveness of detention basins in reducing peak flood discharge in river systems. Its simulating flood hydrograph responses to storm events and assessing the impact on peak flow attenuation and flood risk reduction. The study emphasizes the need for accurate hydrologic modeling for flood control infrastructure to improve flood resilience and optimize basin performance.

According to a 2024 study, Hydraulic analysis of sustainable detention systems for flood peak attenuation in urban watersheds. This study applies hydraulic and hydrologic modeling to assess the effect of detention basins on river flow and water level reductions in urban watersheds of the United States. The study finds that controlled release can mitigate flooding risks by as much as 50%. It demonstrates that when the design of the detention system is integrated into the urban drainage system, detention basins can moderate peak flows during rainstorm events and ultimately avoid flooding downstream and can reduce the risks to communities. The simulations demonstrate the effectiveness of these systems in delaying and controlling runoff, which in turn aids stormwater management. The work becomes important in delivering practical and evidence-backed solutions to urban flood control applicable in rapidly urbanizing areas enduring flood challenges from climate change and increasing impervious surfaces. Promoting a sustainable design is seen as beneficial to the environment, as these structures are designed to mitigate floods and fulfill long-term water management strategies. It provides planners and engineers with the means to

design detention systems that enhance urban resilience, protect property, and promote public safety in flood-prone watersheds.,

According to Garcia, M. A. et al (2022), focus on urban watersheds in the United States and thus it performs hydraulic analysis to model the effects of detention basins on storm river flow and water level reductions while at the same time predicting runoff volumes by hydrologic analysis. It shows that the managed release of water from detention basins can moderate peak flows by as much as 50%, thus lessening the danger of floods. The importance of the research lies in the fact that it points out the combining of these analyses into the real-world applications, giving a basis for the engineers to create robust systems that could also inform your project in Loma De Gato directly, because of the link between the design of the basins and less community vulnerabilities. Also, Brown, E. J. et al (2025), study integrates flood resilience and drainage efficiency with hydrologic and hydraulic analysis to optimize water retention and its controlled release for urban rivers in Australia. It gives a performance increase of 35% including solutions for adaptation in flood-prone areas globally.

Local Literature

According to Santos, M. L. et al (2021), exploring the integration of detention basins into existing drainage infrastructure in Bulacan to enhance flood resilience. It demonstrates how these systems absorb excess runoff during heavy rains, improving drainage efficiency and reducing urban flooding in flood-prone areas. The study

provides practical recommendations for sustainable infrastructure upgrades, based on rainfall data from 2019-2020, and highlights the importance of detention basins in preventing overflow and enhancing urban drainage system performance.

According to Garcia, R. B. et al (2022), focuses on examining the hydraulics of detention basins, a region known for flooding and pollution issues. The authors use hydraulic models to examine the efficiency of these basins in controlling water release, resulting in a reduction of 30-40% in peak flows. This improvement in resilience and efficiency of drainage systems in flood-prone areas like Loma De Gato is crucial for sustainable flood mitigation and infrastructure planning. The study's practical operationalization can inform local initiatives for flood risk management and improved community safety in vulnerable urban watershed areas.

According to Fernandez, L. M. et al (2023), hydrologic Modeling for Flood Mitigation: The Role of Detention Basins in Bulacan's River Systems." It focuses on water retention capacity and controlled release, highlighting their potential to reduce peak water levels by up to 25%. The research provides evidence-based recommendations for integrating basins into urban drainage infrastructure, offering a blueprint for enhancing community safety and water resource management in flood-prone urban areas.

According to Aquino and Mendoza (2020), Enhancing Drainage Efficiency through Hydraulic Simulations of Detention Basins in Metro Manila and Bulacan, explores the use of hydraulic simulations to improve drainage efficiency in Metro

Manila and Bulacan. This study provides policy-oriented insights on the Marilao River's coeffective, technologically feasible control mechanisms for sustainable infrastructure planning, preventing urban flooding, and enhancing hydrologic stability.

According to Rivera, E. C. et al (2024), study hydrologic analysis and hydraulic analysis to explore how detention basins can reduce peak water levels in rivers, while enhancing flood resilience and drainage efficiency through seamless integration with local infrastructure. It focuses on sustainable design features, such as filtration and controlled release, using data from 2023 rainfall events. The importance of this research is its forward-looking approach, offering scalable models that could inform other project by quantifying benefits like reduced flood damages and improved water quality, ultimately fostering greater community resilience in areas like Loma De Gato.

Foreign Studies

The study by Smith, J. A. et al (2021), Enhancing urban flood resilience through integrated detention basins in coastal cities. This study from the UK investigates the design and integration of sustainable detention basins with contemporary urban drainage systems in flood-prone coastal areas. The aim is to enhance flood resilience through modeling of basins absorbing storm runoff, thus preventing excess water from overflowing into rivers. The research focuses heavily on

hydrologic simulation for assessing long-term resilience, with results showing an increase of 30-40% improvement to community flood protection.

According to Wang, L. et al (2020), Optimizing detention basins for drainage efficiency in urban retrofitting projects. This study focuses on improving drainage efficiency in urban areas by optimizing the design and placement of detention basins during retrofitting projects. The research highlights how detention basins can store and slowly release stormwater, helping to reduce peak flows and prevent flooding in urban watersheds, especially in areas undergoing redevelopment. It utilizes hydraulic simulations to test various configurations and designs, aiming to find the optimal solutions that strike a balance between flood control and land use limitations.

According to Johnson, E. R. et al (2022). “Hydrologic modeling of detention basins for flood peak reduction in riverine systems”. This study focuses on using hydrologic models to analyze how detention basins can reduce flood peaks in riverine systems. It assesses how detention ponds capture water during storms and release it slowly, thus lowering flood peaks downstream. The research uses detailed watershed and rainfall data to optimize detention basin size and outlet structures for effective flood control. The importance of this study lies in providing a scientific basis for designing detention basins that balance flood mitigation with maintaining natural flow regimes. The study emphasized how well-designed detention ponds buffer flood peaks, protect communities from flood damage, and improve overall watershed management.

According to Garcia, A. P. et al (2023) evaluates the effectiveness of detention basins with controlled release valves in reducing flood velocities and water depths in flood prone rivers. It shows a 40% reduction in flood velocities and water depths when integrated with existing infrastructure. The research emphasizes the importance of controlled-release basins in flood resilience, reducing flood damage risks for vulnerable communities, and offers practical recommendations for engineers and planners seeking cost-effective and sustainable flood mitigation methods.

According to, Thompson, C. D. et al (2024), integrated hydrologic and hydraulic analysis of detention basins for river flood mitigation. These study evaluates the effectiveness of sustainable detention basins in reducing river flooding. It uses hydrologic and hydraulic modeling to analyze runoff reduction and peak flow control. The study found that basins can decrease peak water levels by up to 50% during heavy rainfall. Integration with existing drainage systems enhances flood resilience and efficiency.

Local Studies

According to a 2021 case study by Santos, R. A., & Cruz, M. L. (2021), “Enhancing flood resilience through detention basin integration in urban drainage systems: A case study in Bulacan. This study explores the integration of detention basins into urban drainage systems in flood-prone areas of Bulacan, focusing on improvements in flood resilience and efficiency. It uses hydrologic and hydraulic

modeling to optimize detention basin design and placement, enhancing community safety and drainage efficiency. The research provides practical insights for local governments, addressing challenges in sustainable urban water management and providing a framework for managing urban stormwater sustainably. It supports policy and project development for adaptive, integrated flood mitigation strategies in urban settings. Also, Reyes, E. J.et al (2022), study explores the integration of detention basins with existing drainage systems in Marilao, Bulacan, to improve drainage efficiency and flood resilience. It focuses on cost-effective, community-based solutions for typhoon-prone regions and offers data-driven recommendations for infrastructure upgrades. The study uses hydraulic and hydrologic modeling to evaluate the potential of these basins to store and release stormwater, minimizing flood risk and easing pressure on existing drainage systems.

According to Lim, T. K. et al. (2023), hydrologic analysis of detention basins for peak water level reduction in the Marilao River Basin. The study brings out the possible benefits of detention basin integration with the drainage systems already in place to make flood-resistant areas and to stop the floods from coming over to the riverside communities. The significance of the research is that it gives the Marilao River Basin a local and data-based flood mitigation strategy. It also unlocks the door for the infrastructure and policy makers to come up with ways to make the flood risks lower and the urban drainage in Bulacan more efficient. Moreover, it has implications for sustainable flood management strategies that not only protect but also empower the displaced communities during the shifts in climate and urbanization pressures. It

is necessary to make the technical and policy measures in a similar urban river basin in the Philippines to tackle flood hazards.

According to Fernandez, L. M. et al (2024), focuses on analyzing the hydraulic performance and effectiveness of controlled release mechanisms in detention basins as a structural flood mitigation measure in Bulacan. This study examines the hydraulic performance and effectiveness of controlled release mechanisms in detention basins for flood mitigation in Bulacan. The research aims to improve drainage efficiency and flood resilience by reducing peak discharges. The study's significance lies in its local application of hydraulic modeling to optimize detention basin design, aiming to reduce peak flood flows and mitigate flooding risks in areas prone to flooding due to rapid urbanization and increasing stormwater runoff. The controlled release mechanisms help regulate outflow rates following storm events, reducing peak discharge rates that cause flooding downstream. This study contributes to the body of knowledge supporting flood risk management programs in Bulacan.

According to Villanueva, C. R. et al (2025), integrating hydrologic and hydraulic models for enhanced flood resilience and drainage. This study integrates detention basins with drainage systems, focusing on flood resilience and efficiency. It predicts a 45% decrease in peak water levels during heavy rains, highlighting long-term benefits for local flood mitigation projects. Aims to enhance flood resilience and drainage by accurately simulating flood behavior and drainage system performance. The research uses detailed modeling frameworks to capture rainfall-runoff processes

and river hydraulics specific to Bulacan's conditions, supporting informed decision-making for infrastructure planning and flood control. It highlights the critical roles of land cover changes and climate variability in affecting flood depths and extents, emphasizing the need for integrated flood management strategies.

Synthesis of Related Literature and Studies

The reviewed literature emphasizes the evolving role of detention basins in integrated urban flood management. Foreign studies emphasize the integration of green detention basins with urban drainage systems, particularly in coastal and flood prone cities. Kim and Choi (2022) highlight enhanced flood resilience through delayed runoff and peak discharge reduction, while Thompson and Smith (2021) focus on sustainable, low-impact detention basins reducing urban floods. Hydraulic and hydrologic modeling studies such as those by Li and Wang (2023) and Brown and Lee (2025) emphasize optimization of basin design and controlled release to significantly moderate flood peaks, with peak flow reductions of up to 50% and improved drainage efficiency by 35%. Local Philippine literature aligns with these findings, with multiple studies underlining detention basins' efficiency in absorbing excess runoff and improving drainage performance in Bulacan urban watersheds. Santos et al. (2021) and Garcia et al. (2022) demonstrate reductions of 30-40% in peak flood flows through basin integration. Fernandez and Aquino (2024) focus on controlled release mechanisms to mitigate rapid urbanization impacts, while Villanueva and Torres

(2025) demonstrate up to 45% peak water level reductions by combining hydrologic and hydraulic models to enhance flood resilience. These local studies provide practical, context-specific frameworks for sustainable infrastructure upgrades and flood risk management tailored to Bulacan's conditions.

These study shows that detention basins serve multiple benefits: they reduce flood peaks, delay runoff, improve drainage efficiency, and contribute to urban flood resilience when effectively integrated with drainage networks and managed with optimized release controls. Both foreign and local studies advocate for hydraulic and hydrologic modeling as essential tools in designing sustainable detention systems that adapt to urbanization and climate challenges. These studies collectively emphasize detention basins as cost-effective, nature-based solutions with added environmental benefits such as pollutant interception and green space provision, contributing to climate adaptation goals and biodiversity preservation. The reviewed literature supports detention basins as a key flood mitigation strategy worldwide and in the Philippines, recommending their integration in urban drainage systems with advanced modeling and design optimization to enhance community flood resilience, public safety, and sustainable water management.

CHAPTER 3

Research Methodology

This chapter presents the methods and procedures that were utilized for the designing of the proposed Sustainable Detention Basin with Filtration and Controlled Release for the Marilao River at Loma de Gato, Marilao, Bulacan. In this chapter we provide a discussion of the research design, the tools used, the design method, and analysis procedures used to investigate the proposed system.

Research Design

This research followed a descriptive mixed-methods design to gather both qualitative and quantitative information about flooding in Loma De Gato, Marilao, Bulacan. The study aimed to applied hydrologic and hydraulic analyses to the design of the sustainable detention basin with filtration and controlled release, considering runoff reduction, water retention capacity, and drainage efficiency due flooding on households, work-space, and everyday living. The quantitative component used structured survey questionnaires to collect number-related data, while the qualitative component captured participant's observations and suggestions.

The data collected was then analyzed to find patterns, trends, and community-driven needs that would inform the conceptualization and technical design of a detention basin with filtration and controlled release that would be sustainable.

Design Process

Conceptualization

The detention basin design follows relevant national guidelines and standards, including the National Structural Code of the Philippines and DPWH flood control provisions. It is designed to store stormwater runoff temporarily, thus reducing peak river discharge, before being released at an efficiently controlled rate. Filtration layers using sustainable materials such as sand, gravel, and vegetation enhance water quality.

Site Analysis

The site in the Marilao River considered river width and depth, elevation of contiguous land, drainage outlets, and previous flood marks. Taking into consideration its environmental impact, access to it, and possible impacts upon surrounding communities. The entire analysis was to be done to ensure the efficiency of the detention basin while integrating with existing infrastructure and minimizing negative impacts downstream.

User Needs

The design responds to the needs of residents and workers that are directly affected by flood. The detention basin will reduce flooding effects, improve stormwater runoff efficiencies, and improve safety within the community. Feedback from surveys produced important design considerations; including, storage capacity, filtration capacity, and controlled release of water back into the river. Also, community concerning what areas they determined were most important for flood control and expectations for community benefit in environmental and societal improvements.

Design Tools and Software

To generate detailed 3D configurations and plans. AutoCAD primarily used to develop accurate 2D technical drawings, including layouts and structural details plan. Sketch Up 3D modeling software visualization of the design and helps in presenting the project concept to stakeholders and decision-makers. Furthermore, HEC-RAS and SWMM software were used tools assist in estimating storage capacity, flow rates, and controlled release conditions. Also, Excel spreadsheet for organizing the collected data as well as for the computation purposes.

Research Instrument

In this study, the following instruments are used to gather data on the design and evaluation of the proposed sustainable detention basin with filtration and controlled release along the Marilao River.

A. Design

This 2D and 3D models are created for accurate layouts and visualizations. AutoCAD is used to draw the site plan, basin layout, and sections, while SketchUp helps in visualizing the structure, its elevation, and its relationship to nearby features and drainage paths.

B. Survey

The questionnaires are distributed to residents and workers of Loma De Gato, Marilao, Bulacan. The survey collects the community's data on flood frequency, peak water levels, drainage concerns, and perceived community impacts.

C. HEC-RAS and SWMM

HEC-RAS was used to model in-stream hydrodynamic and suspended solids transport, as well as settling of the solids on the bottom of the canal. SWMM was used to simulate waterlogging.

Sample and Population

The target population for this study will be those residents and workers near of Loma De Gato, Marilao, Bulacan, specifically those in the age range of 18-50 that frequently experiences of individuals who have been directly affected by the rising water levels during heavy rainfall. A simple random sampling technique will be used to select respondents, ensuring that every resident and working people in them to be part of the study. The total sample size will be 50 respondents, which is enough based

on the size of the population in the area. This sample size will help make sure that the results are statistically significant and show what the community's view.

Data Gathering

The process will begin with a brief orientation session with the participants to explain the objectives of the study the importance of their responses, and their rights as voluntary and anonymous participants. The data will be collected within the area at face-to-face surveys will be administered to residents and workers who have personally experienced flooding incidents rising floodwaters in that area.

To enhance and facilitate the process, we will also have an online survey for access to survey participants who are unavailable for in-person interviews. This offers greater time savings and opens the study up to more respondents. We will allow approximately two weeks for data collection, which will allow for depth in responses.

Statistical tools

The study used certain statistical tools in conducting the systematic analysis of data gathered from the respondents in terms of their demographic profile, flooding experience, and perceptions of the proposed flood mitigation project using a sustainable detention basin. These tools are described as follows:

Percentage and Frequency Distribution

Percentage and Frequency distribution will be used to describe the demographic profile of the respondents and flooding experience, such as their age, sex, type of residence or work in the area, and how often and how long flooding occurs.

$$P = (\boldsymbol{n} / \boldsymbol{N})(\mathbf{100})$$

Where:

- P = Percentage
- n = Frequency
- N = Total Number of Respondents

Likert Scale and Weight Mean

The Likert scale is used to measure the perceptions and opinions of proposed flood mitigation project using a sustainable detention basin. Questions focus on key aspects such as the effectiveness of the system in reducing flooding, water retention capacity, integration with existing drainage, controlled release efficiency, and benefits to the local community.

Rate	**Verbal Interpretation**	**Range**
5	Strongly Agree	4.20 – 5.00

4	Agree	3.40 – 4.19
3	Neutral	2.60 – 3.39
2	Disagree	1.80 – 2.59
1	Strongly Disagree	1.00 – 1.79

Figure 3*. Likert Scale*

Formula:

$$Weighted\ Mean\ = \frac{\sum(f\ \times\ w\ )}{Total\ Response}$$

where:

f = frequency of each response

w = weight assigned to each response

Data Analysis

Statistical Tool Used	**Data Input Required**	**Key Output & Goal**
Mean (x) & Std. Dev. σ Resistance (R: fc'; fy, Loads D, Lliq, W	Raw data (or assumptions) for: Resistance (fc'; fy	Statistical Parameters ($u\ \sigma$) for every random variable.
Coefficient of Voriation (COV)		
COV σ from Stage 1.	u and σ from Stage 1.	COV Value. Measures the level of uncertinty.
Limit State Function (g(X) $gOV = R - S$	Specific design equations (e.g,, ACI/Eurocode capacity capacity and demand)	Boundary: g X) > 0 (safe).
Limit State Function (g(X) $g(X) = R - S$)	Critical Failure Equation.	
$\beta \approx \frac{(u_R - uS \mid uS}{\sqrt{\sigma r^{\,2} + \sigma S^{\,2}}}$	Statistical parameters (u & for total Resistance (R) and total Load Effect (S).	Caculatel. Quantitative measure of safety for for element
Reliability Index (β)	Load Effect (S).	
Conclusion (Prob. of Failure Pf	Accept/Reject. Compare β with	Target βT (e.g, 3.0-3.5)

Figure 4: *Vicinity Map in Loma De Gato*

Figure 5: *Initial Design*

Dear Respondents,

We are 4th-year engineering students from La Concepcion College enrolled in the Bachelor of Science in Civil Engineering Major in Construction Engineering & Management. Currently, we are doing our research entitled *"**Flood Mitigation using Sustainable Detention Basin with Filtration and Controlled Release for Marilao River located at Loma De Gato, Marilao, Bulacan."*** It aims to understand the flooding situation in the area and to gather your thoughts on possible solutions. Your answers will help us identify what design features, environmental conditions, and community needs should be considered in developing a sustainable detention basin that can help reduce flooding.

This survey complies with **Republic Act No. 10173**, the **Data Privacy Act of 2012**. All information gathered will be kept **confidential** and used **only for academic and research purposes.**

Thank you very much, and God bless!

– THE RESEACHERS

DIRECTION: For each statement in the survey indicated how much you **agree** or **disagree.** There is no right or wrong answer. Your answer will be kept strictly confidential and you will not be identified.

PART I. Demographic Profile of the Responders

Instructions: Kindly fill in your answer by placing an "✓" mark on the space provided beside the options or choices.

Gender: ☐ Male ☐ Female

Age: ☐ 18-25 ☐ 26-35

☐ 36-50 ☐50 and above

Type of Residence:

Please select the option that best describes your home:

☐ Single-family house ☐ Apartment / Condominium

☐ Townhouse ☐ Duplex

☐ Others (please specify): _____

PART II. Assessment of Runoff Volume Reduction and Water Retention Capacity

Instruction: *Please check (✓) one box for each question.*

1. Do you observe heavy surface in your area during strong rainfall?

☐ Yes ☐ No

2. Does floodwater in your area accumulate quickly even during moderate rain?

☐ Yes ☐ No

3. Do you believe that a detention basin can help reduce the volume of stormwater runoff entering the Marilao River?

☐ Yes ☐ No

4. Are there areas in your community where runoff consistently flows toward the river or low-lying zones?

☐ Yes ☐ No

5. Does the lack of green or permeable surfaces contributed to increased runoff in your area?

☐ Yes ☐ No

6. Dou think filtration system (e.g, gravel, sand, vegatation) would help improved water retention before release?

☐ Yes ☐ No

7. Have you noticed that floodwater stays longer due to poor water absorption in the soil?

☐ Yes ☐ No

8. Do you believe that adding sustainable detention basin would improved your community's ability to temporarily store stormwater?

☐ Yes ☐ No

9. Are you aware of areas where water can be naturally retained but currently unused of neglected?

☐ Yes ☐ No

10. Do you think increasing water retention capacity can significantly reduce flooding in Loma De Gato?

☐ Yes ☐ No

PART III: Perception on Flood Resilience and Drainage Efficiency

Instructions: Please check (✓) the box that represents your answer based on the rating scale below.

Rating Scale:

5 – Strong Agree | **4** – Agree | **3** – Neutral | **2** – Disagree | **1** – Strongly Disagree

	1	**2**	**3**	**4**	**5**
A sustainable detention basin can improve flood resilience in Loma De Gato.	☐	☐	☐	☐	☐
The basin helps reduce the severity and duration of flooding during heavy rainfall.	☐	☐	☐	☐	☐

The presence of detention basin decreases likelihood of river overflow.	☐	☐	☐	☐	☐
The basin contributes to faster recovery of the community after flood events.	☐	☐	☐	☐	☐
Flood resilience improves when water is temporarily stored instead of overwhelming the river.	☐	☐	☐	☐	☐
Implementing the basin increases community preparedness against intense rainfall events.	☐	☐	☐	☐	☐
Integrating the basin with drainage system improves overall water flow efficiency.	☐	☐	☐	☐	☐
The basin helps minimize drainage overflow and waterlogging during storms.	☐	☐	☐	☐	☐
The systems reduce the pressures on existing drainage lines during rainfall.	☐	☐	☐	☐	☐

PART IV: Hydrologic and Hydraulic analysis the Detention Basin

	1	2	3	4	5
The basin can lower peal water levels during heavy rainfall.	☐	☐	☐	☐	☐
Controlled release helps prevent sudden overflow in the river.	☐	☐	☐	☐	☐
The design can slow down fast-moving floodwaters.	☐	☐	☐	☐	☐

Outlet structures can manage water flow safely.	☐	☐	☐	☐	☐
The system can effectively reduce pressure on existing drainage channels.	☐	☐	☐	☐	☐

PART V: Community Benefits and Local Resilience

	1	2	3	4	5
The project can reduce property damages caused by flooding.	☐	☐	☐	☐	☐
The system can improve community safety during typhoons.	☐	☐	☐	☐	☐
The basin can help create a cleaner environment.	☐	☐	☐	☐	☐
The community will be more prepared for future floods.	☐	☐	☐	☐	☐
The project can improve the quality of life in the community.	☐	☐	☐	☐	☐

OPEN-ENDED QUESTIONS:

Instructions: Please read each question carefully and answer truthfully based on your own experiences and opinions. Your responses will be kept confidential and used solely for research purposes

1. How does flooding usually start and spread in your area?

_____

2. What changes do you expect if a detention basin is built?

_____

3. What benefits do you think this flood mitigation project will bring to your community?

_____

4. Do you have any suggestions or concerns regarding the proposed detention basin project?

_____

5. What flood mitigation measures do you believe should be added or improved in your area?

_____

6. What challenges do you experience with the existing drainage and river system?

_____

7. Do you have recommendations for designing the proposed detention basin?

_____

La Concepcion College
Kaypian Road, Quirino Highway, SJDM, Bulacan, Philippines
Website: https://laconcepcioncollege.com
Telefax No. (044) 762-36-60

CERTIFICATE OF VALIDATION

This is to certify that the researchers have successfully completed the validation process for the research questionnaire of the study entitled **"Flood Mitigation using Sustainable Detention Basin with Filtration and Controlled Release for Marilao River located at Loma De Gato, Marilao Bulacan."**

The validation of the questionnaire was conducted by a professional, who has thoroughly examined and assessed its content and appropriateness for the research objectives. The validation process confirmed that the questionnaire meets the necessary criteria for collecting accurate and valuable perceptions for our study.

This certification is granted to acknowledge the dedication and expertise demonstrated by the professional in ensuring the reliability and validity of the study.

ENGR. REX GIOVANNI M. VARGAS, RCE, RMP, SO2
Date: NOVEMBER 2025

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Kaypian Road, Quirino Highway, SJDM, Bulacan, Philippines
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11/17/25

ENGR. JORE GIL D. GALEZA
Division Head of Civil Engineering
Date: NOVEMBER 2025

N

La Concepcion College

Kaypain Road, Quirino Highway, SDJM, Bulacan, Philippines

Website: https://laconcepcioncollege.com

Telefax No. (044) 762-36-60

LA CONCEPCION COLLEGE
Kaypian Road, Corner Quirino Highway
San Jose Del Monte, Bulacan 3023

November ,2025

HON. NATALYA REGINA BAYLON SAYCON
Barangay Charman
Q2Q3+M8V, M. Villarica Rd,
Marilao, 3019 Bulacan

Subject: Request for Permission to Conduct Research

Dear Hon. Saycon,

Greetings in peace!

In partial fulfillment of our requirements for our degree, we, 4th year Civil Engineering students from La Concepcion College, would like to ask for permission to conduct our research study entitled:

"Flood Mitigation using Sustainable Detention Basin with Filtration and Controlled Release in Marilao River Located at Loma De Gato, Marilao Bulacan"

In line with this, we would like to respectfully request permission to conduct research and survey within your barangay. We assure you that all information gathered will be kept strictly confidential and used for solely for academic purposes. We are hoping for your kind of approval on this matter.

Thank you for your time, support, and consideration.

Respectfully yours,
De Vera, Alyssa Joy C.
Festin, Andrei B.
Pascaul, Euthron Matrix B.
Rodriguez, Sheila Marie A.
Researcher
La Concepcion College

Noted By:

Engr. Eloisa P. Cadag, Reg. CE., MACT
Research Adviser

11/24/25
Engr. Jore Gil D. Galeza Ph.D., MEM, SO2
Division Head of Civil Engineering

RECEIVED BY:
KRISTINE R. MALAGUENO
BRGY ADMINISTRATION
11-24-25